The Chemical Context of Life
Chapter 2

Elements, Molecules and Compounds

- Substances that can be broken down to other substances by a chemical reaction:
  - 92 occur in nature
  - 25 essential for life

- Smallest unit of an element

Elements

- Have a one or two letter
- 4 make up 96% of living organisms:
  - (C)
  - (H)
  - (O)
  - (N)

Parts of the Atom

- __________ – __________ charged
- __________ – __________ charged
- __________ – __________ charged
- __________ – __________ charged

Atomic Number

- Atomic Number = __________ of __________
  - Unique to that element
- Atomic number written as __________ to __________ of symbol
  - e.g. _2^He_
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Atomic Weight
- Measured in ____________ (1 dalton $\approx 1.7 \times 10^{-24}$ g)
- Protons weigh _______ dalton
- Neutrons weigh _______ dalton
- Electrons weigh 1/2000 of a dalton
- Atomic weight (mass) = weight of _______ + weight of _______
  • Ignore the mass of _______ in the total mass of an atom
- Atomic weight is written as a _______ to _______ of symbol
  • e.g. $^4_2$He

Parts of the Atom
- _______ – _______ charged
  • Protons – positively charged
  • Neutrons – no charge
- _______ – _______ charged

Charged Particles
- Nucleus (core) has net positive charge
  • _______ and _______
- Electrons are _______ to the positively charged nucleus
  • Electrons circle outside of the nucleus at the speed of light
- Atom is _______ in charge if protons = electrons

Atomic Number, Weight, and Charge
- Atomic number = number of protons
- Atomic weight = number of neutrons + number of protons

- When # protons = # electrons, then there is no (__________) charge
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Examples

- Boron
  - Atomic number 5
  - Atomic mass 11
  - How many protons? __________
    - Electrons? __________
    - Neutrons? __________

- Aluminum
  - Atomic number of 13
  - Atomic mass of 27
  - How many protons? __________
    - Electrons? __________
    - Neutrons? __________

**Electron __________ – Position in Relation to Nucleus**

- __________ charged __________ electrons attracted to __________ charged protons
- More __________ energy if farther away
- Potential energy in electrons changes in steps
  - __________ shell __________ in potential energy
  - __________ shell __________ in energy

**Electron __________**

- 1st shell: one orbital – __________ electrons
- 2nd shell: four orbitals – __________ electrons
- 3rd shell: four orbitals – __________ electrons
- Electrons __________ the __________ shells completely first
- No more than __________ electrons in the same orbital
- Unpaired electrons are __________

**Valence Shells**

- Outer shell of electrons = __________ shell
- Number of __________ in valence shell determines how __________ an atom is
- Atom with a __________ valence shell is __________ (“inert” or “noble element”)

**Valence Shells of 1st 18 Elements of the Periodic Table**

- Arranged in rows according to how many __________ in the valence shell
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Chemical

- How atoms stay together to form ________
  - Only ________ interact to make bonds
- Bonds occur by ________ or ________ valence electrons
  - To complete their valence shell
- ________ ________ = ________
  - Electrons needed to fill the valence shell
    - H: 1
    - O: 2
    - N: 3
    - C: 4

Electronegativity

- The strength of the pull on electrons by the atom’s nucleus
- Shared electrons pulled by both nuclei
  - Tug of war for electrons
- Atoms of different elements have different ________
- ________ one of the ________ electronegative of the 92 atoms
  - Often has unequal electron sharing

Types of Bonds

- ________ – strongest
  - ________ -polar
  - ________
- ________ – medium in strength
- ________ – weak
- ________ der ________ interactions
  - Very weak – not even a real bond

Covalent Bonds

Sharing a pair of valence electrons

- Very ________
- e.g. Hydrogen
  - 1 valence electron
  - Valence capacity is 2
- e.g. Oxygen
  - 6 valence electrons
  - Valence capacity is 8
  - Can share ___ pairs to make double bond
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Polar & Non-Polar Covalent Bonds

- Electronegativity
  - How strong atom’s nucleus pulls on electrons
  - ________ - ________ bonds
    - ________ electronegativity ________ electrons ________
  - ________ bonds
    - ________ electronegative atoms pull electrons ________

Non-Polar Covalent Bonds

- Atoms of pure elements have ________ electronegativity
  - H₂ and O₂
- Atoms of compounds may have ________ electronegativity
  - Methane – CH₄
    - 1 valence electron in H
    - 4 valence electrons in C
    - Four single covalent bonds

Polar Bonds

- Highly electronegative atoms pull electrons closer
- e.g. Oxygen
  - ________ electronegative
- Water – H₂O
  - 1 valence electron in H
  - 6 valence electrons in O
  - Two single covalent bonds
  - Electrons stay ________ to Oxygen
  - Oxygen has ________ negative charge
  - Each hydrogen has ________ positive charge
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Ions and Ionic Bonds

- When electronegativity is ___________ different
- One atom _________ an electron from it’s partner
  - Results in ___________ atoms
- ___________: Charged atom or molecule (+ or -)
- ___________ ___________: opposite charge ions attracted
  - ___________: A negatively charged ion (1+ electrons gained)
  - ___________: A positively charged ion (1+ electrons lost)

Hydrogen Bonds

- ___________ - Charge Attractions
  - H atom with ___________ charge also attracted to another electronegative atom
  - Attraction between charged portions of polar molecules
    - Opposites attract
  - ___________ bonds
    - Important in properties of ___________

Van der Waals Interactions

- Electrons in motion sometimes asymmetrically distributed
- Changing ___________ - ___________ of ___________
- Allow molecules and atoms to stick together
- Very weak
  - Fall apart really fast

Single bonds

- Hydrogen
  - One valence electron
  - Structural formula (bonding shown)
    ___________
  - Molecular formula (no bonding shown)
    ___________
Double bonds

- Oxygen
  - Six valence electrons
  - Structural formula (bonding shown) _____________
  - Molecular formula (no bonding shown) ___________

Formulas

- ___________ formula
  - Atoms ___________ bonds represented
  - e.g. Water: H—O—H
- ___________ formula
  - ___________ shown (no bonding shown) H₂O